In-Field Study Evaluating Rates of TCE Biotransformation using Carbon-Based Biostimulation Additive ERDenhancedTM Alone vs. Erdenhanced Combined with Zero Valent Iron (Zvi).

Kent Armstrong, TerraStryke Products

Site Incidental releases of Trichloroethene (TCE) at former electronics manufacturer adversely impacted shallow overburden-bedrock groundwater. Hydrogeology consists of 15-20 feet of alluvial silty clay and/or gravelly sand overlying fractured sandstone with a 10-foot interval of dense non-aqueous phase liquid (DNAPL) trapped in primary/secondary porosity of shallow bedrock.

Concern Baseline [TCE] in bedrock ranges from 55-550 milligrams per liter (mg/L), up to ≈30% aqueous solubility limit; dechlorination byproducts cis-1,2-Dichloroethene (cis-1,2-DCE) at ≤15 mg/L and Vinyl chloride (VC) detected below method detection limits (0.25-10 mg/L). Site pump & treat systems operate to manage plume migration. Responsible party desires low-impact, low-cost strategy that achieves sustainable enhanced reductive dechlorination (ERD) which targets DNAPL destruction.

Strategy In 2021 an on-Site Proof-of-Concept (POC) study was implemented to evaluate ERDenhancedTM, a carbon-carbohydrate based biostimulant formulated with proprietary blend of macro-micronutrients, and a modified ERDenhancedTM which included a small percentage of Zero Valent Iron (ZVi). The POC study evaluated the efficacy of each formulation to enhance indigenous microbial population's ability to support reductive dechlorination in terms of reducing/destroying both dissolved-phase concentrations and molar concentrations of the above noted chlorinated volatile organic compounds (cVOCs). Additional performance metrics include rates of residual mass solubilization, daughter cVOC generation/production and, Ethene production. Bioaugmentation was not performed.

Process Two monitoring wells amended using Passive Release Sock (PRS) deployment units; one filled with ERDenhancedTM (MW-23A), a second (MW-24A), with ERDenhancedTM and 15% by weight ZVi. Baseline groundwater monitored and sampled for laboratory testing of geochemical and site contaminants of concern from each test well using non-purge low-flow techniques. PRS units were removed/replaced every 6-weeks. Groundwater monitoring/sampling and analytical testing performed concurrent with each replacement event. Overall 7 Baseline/replacement events performed during 12-month evaluation.

Results The biotic ERDenhancedTM formulation and combined biotic/abiotic ERDenhancedTM/ZVi demonstrated identical reductions in dissolved-phase parent TCE realizing, by month 3, >99.99% reductions. In terms of overall performance, the combined ERDenhancedTM/ZVi formulation consistently outperformed the biotic formulation demonstrating introduction of a relatively small percentage of ZVi catalyzed biological performance. Overall, dissolved-phase concentrations of total cVOCs decreased 89.0% at MW-24A, ≈30%more efficient than MW-23A (65.9%). Additionally, reductions in dissolved-phase cVOCs from peak bioavailability started in June at MW-24A, 2-months before MW-23A and, total moles cVOCs decreased 50% at MW-24A vs. 30% at MW-23A. Production of Ethene, indicator of complete TCE biotransformation, was similar at each location; however, like other metrics it appeared 2-months faster at MW-24A than MW-23. Each performance metric noted indicates more efficient biological activity. Additionally, utilization of alternative electrons Sulphate, Manganese and Iron was observed to be expedited and in greater synchronicity at MW-24A vs. MW-23A, each metric a secondary indicator supporting the hypothesis of catalyzed/expedited biological activity.

Conclusion Biostimulation alone with ERDenhancedTM achieves robust

and complete TCE DNAPL dechlorination without "cis stall"; however, addition of relatively small percentage of ZVi catalyzed and beneficially increased overall performance. The

modified ERDenhancedTM realized expedited solubilization

(elimination of rebound), expedited daughter cVOC production and expedited, complete dehalorespiration with molar destruction; sustainably with less-impact, fewer deployments, no aboveground support equipment, and lower overall project costs.

Kent Armstrong

A Graduate of California State University Long Beach, 'The Beach'; B.S. Terrestrial Ecology (Zoology), minor in Philosophy/Religious Studies, with Graduate Studies in Palynology (fossil pollen) and Paleoecology.

Numerous jobs as a butcher, human anatomy instructor, ravioli maker, warehouse and parts dispatch operator...real work began with the Los Angeles County Sanitation District as Plant Laboratory Chemist and then as a Treatment Plant Operator.

Over the next 35 years, Kent would work for and aid both government and corporate businesses with remediation strategies as a contractor, consultant, and general nice guy.